Small-scale Forestry (2007) 6:79–92
DOI 10.1007/s11842-007-9006-2

ORIGINAL PAPER

# Describing management attitudes to guide forest policy implementation

**Tove Enggrob Boon · Henrik Meilby**

Received: 22 November 2006 / Accepted: 20 January 2007 / Published online: 27 February 2007


**Abstract** Forest policy in Denmark aims to increase the environmental values of forests. For policy implementation it is essential to know how to motivate private owners. Based on a survey among private forest owners in Denmark, four types of owners have been identified, clustered according to their forest management attitudes and practices: (1) the production-oriented owner, (2) the classic forest owner, (3) the environmental/recreational owner, and (4) the indifferent forest owner. Owners in Clusters 1 and 2 are mainly motivated by financial and wood production aspects, whereas owners in Cluster 3 are to a greater extent motivated by environmental and recreational aspects. Cluster 4 is the least motivated cluster. For effective policy intervention, the clusters should be addressed by different means. Owners in Clusters 1 and 2 should be met on their agricultural-production logic, Cluster 3 on their interest to improve environmental values, whereas owners in Cluster 4 might mainly be interested in passive nature management solutions.

**Keywords** Forest owners · Forest management · Latent class cluster · Policy advice · Typology

## Introduction

The ecological sustainability of forests is a major concern of past and current forest policy. Like in most other European countries, work has been done in Denmark to operationalise what constitutes ecologically sustainable forestry. Subsequently, the public forest administration has designed schemes and information material aimed to enhance nature considerations in forest management. In 2004, the *Forest Act* was

T. E. Boon (✉) · H. Meilby
Faculty of Life Sciences, Danish Centre for Forest, Landscape and Planning, University of Copenhagen, Rolighedsvej 23, Frederiksberg C 1958, Denmark
e-mail: tb@life.ku.dk

H. Meilby
e-mail: heme@life.ku.dk

revised in order to support a more near-to-nature management, e.g. replacing exotic species with site-adapted indigenous species, choosing natural regeneration instead of replanting, and allowing for the development of multi-storey, uneven-aged forest where possible (Skov- og Naturstyrelsen 2004).

For forest policy instruments to be effective, they must motivate forest owners to adjust behaviour in agreement with forest policy objectives. But what actually governs the forest owners' choice of forest management?

In Denmark, 49% of the forest area is under private individual ownership (24,900 owners) (Larsen and Johannsen 2002). Are forest owners equally governed by ecological concerns or can they be grouped according to management attitude profiles?

The aim of the present paper is to describe a typology of forest owners based on their attitudes towards key forest management practices (tree species choice and choice of regeneration method) and actual management behaviour during a period of 5 years. Based on this, and with knowledge about the organisational affiliations and information channels of each of the owner types, strategies are suggested to target each owner type with policy and advisory services.

## Forest Owner Typologies

A number of forest owner typologies have been proposed by researchers, a few being based on qualitative in-depth interviews (e.g. Madsen 2003), some subjectively determined without any formal data (e.g. Volz and Bieling 1998, Vanclay 2005), but most based on quantitative survey data. These typologies are mainly defined according to differences with regard to ownership objectives (e.g. Kuuluvainen et al. 1996; Karppinen 1998a, b; Volz and Bieling 1998; Becker et al. 2000; Kline et al. 2000; Bieling 2004; Boon et al. 2004; Ingemarson et al. 2006). A review of typologies by Boon et al. (2004) identified five main owner types: (1) 'the economist', (2) 'the multi-objective', (3) 'the self-employed', (4) 'the recreationist', and (5) 'the passive/resigning'.

A few typologies are based on socio-demographic characteristics of owners. These studies focus on the emergence of 'new' urban owners (Härdter 2002; Hogl et al. 2005), i.e. owners with little or no agricultural affiliation, living in urban areas and deriving their income from outside agriculture or forestry. No typologies so far are based on forest owners' management attitudes and practices.

The purpose of a forest owner typology is to differentiate between groups of forest owners, i.e. to obtain a more comprehensive but still 'simple' overview of forest owners. A typology does not have the explanatory power as, for example, a study based on theory of planned behaviour, but it is a potentially useful tool for communicative purposes and for policy design. In practice, however, typology studies struggle to move beyond the mere static characterisation of the identified owner types, to provide policy recommendations based on the added knowledge, and to create links between the types and the forest owners in real life, as also identified by Emtage et al. (2006). Based on a review of landholder typologies, Emtage et al. (2006) identified a set of factors that are critical for improving the practical utility of typologies, i.e. the classification criteria and methods used to guide the typology, the geographical focus and scaling, as well as the focus on one or multiple industries.

## Research Method

A postal survey of Danish private forest owners was carried out by the authors in collaboration with Statistics Denmark in February and March 2002. The population consisted of all (15,903) owners of private, personally owned forest properties with an area of at least 2 ha. Questionnaires were distributed to a stratified sample of 1,986 forest owners of whom 63 were omitted from the sample as 'non-relevant', because the recipients stated that they did not own any forest. Of the remaining 1,923 forest owners 1,553 responded, a response rate of 80.8%. Further information about the survey and the sample can be found in Boon (2003), Boon et al. (2004), and Meilby and Boon (2004).

The questionnaire included 27 questions concerning:

- the forest (area, location, tree species composition).
- the owner (age, gender, income level, type and duration of ownership).
- perception of the importance of forest benefits (e.g. financial performance, hunting, recreation).
- forest management attitudes and practices.

The aim of this study is to develop a typology that groups forest owners according to their attitudes towards forest management practices and their actual management behaviour during a period of 5 years. Although information about management attitudes was gathered, it is not known what motivated a given answer and what kind of behaviour could be expected with a given set of responses. In principle, two forest owners might value equally the fact that a tree species is financially valuable, and still choose totally different species. This means that it is not possible to deduce forest owners' actual behaviour from their responses in a survey. Therefore it was decided to group forest owners not only according to their stated attitudes but also according to their actual management behaviour during the 5 years up to the time of the survey.

More explicitly, the questions in Table 1 form the basis of the typology. These include Question 19 regarding actual management behaviour during a period of 5 years, Question 20 regarding factors influencing tree species choice, and Question 21 regarding factors influencing choice of felling and regeneration method. Percentages of positive answers to Question 19 and average ratings for Questions 20 and 21 are reported in Table 1 for each of the four clusters. In Question 19, activities that had taken place were ticked off in a list, implying that the response variables are binary. All sub-questions of Questions 20 and 21 were answered using the same five-level ordinal (Likert) scale: 1 = very important, 2 = important, 3 = neither nor, 4 = not important, 5 = absolutely not important.

The survey data were analysed using latent class cluster analysis (software: LatentGOLD v.3.0.6). The basic idea of latent class analysis is that, apart from dependent and independent variables observed when sampling a population, a number of latent, unobserved variables may exist. These latent variables indicate that the population is, in reality, a conglomerate of sub-populations, each of which has its own distribution with respect to the observed variables. In latent class cluster analysis a statistical model is developed and used to examine how many different classes the population appears to fit in and what the characteristics of the sub-populations are.

**Table 1** Variables forming the basis of the latent class cluster analysis. Percentages and mean values for each cluster

| Question no. | Question | Cl | C2 | C3 | C4 |
|---|---|---|---|---|---|
| 19 | ''Which of the following activities have been carried out in your forest during the past 5 years?'' | % | % | % | % |
| | Fuelwood cutting | 78[a] | 93[b] | 95[b] | 75[a] |
| | Christmas tree harvest | 35[a] | 63[b] | 36[a] | 21[c] |
| | Greenery harvest | 34[a] | 69[b] | 34[a] | 17[c] |
| | Thinning | 53[a] | 92[b] | 84[c] | 32[d] |
| | Clear-felling | 16[a] | 71[b] | 41[c] | 12[a] |
| | Soil preparation | 9[a] | 64[b] | 32[c] | 1[d] |
| | Spraying | 28[a] | 74[b] | 37[c] | 9[d] |
| | Planting after (clear) felling | 51[a] | 93[b] | 75[c] | 27[d] |
| | Afforestation | 14[a] | 54[b] | 45[c] | 14[a] |
| | Recreational facilities | 9[a] | 27[b] | 34[b] | 10[a] |
| | Game management | 42[a] | 78[b] | 81[b] | 38[a] |
| | Nature management | 22[a] | 64[b] | 66[b] | 21[a] |
| | Nature concerns, other | 11[a] | 62[b] | 57[b] | 18[a] |
| | Management planning | 5[a] | 61[b] | 28[c] | 1[a] |
| | Other activities | 2[a] | 4[a] | 2[a] | 3[a] |
| 20 | ''How important is each of the following factors for your choice of tree species?'' | Av.* rating | Av. rating | Av. rating | Av. rating |
| | Plant price | 2.9[a] | 2.9[a] | 3.7[b] | 4.4[c] |
| | Subsidies | 2.9 [a] | 2.5 [b] | 3.1[c] | 4.2[d] |
| | The species is economically valuable | 2.6[a] | 1.9[b] | 3.4[c] | 4.4[d] |
| | The species is fast growing | 2.9[a] | 2.8[b] | 3.7[c] | 4.6[d] |
| | The species has a stable cultivation phase | 2.3[a] | 1.8[b] | 2.5[c] | 4.2[d] |
| | The species is robust against storm, pests etc. | 2.2[a] | 1.6[b] | 2.2[a] | 4.0[c] |
| | The species is site adapted | 2.0[a] | 1.5[b] | 1.9[c] | 3.7[d] |
| | It is a deciduous species | 2.8[a] | 2.3[b] | 2.3[b] | 3.8[c] |
| | It is a coniferous species | 2.9[a] | 2.9[a] | 3.2[b] | 3.9[c] |
| | The species is aesthetic (nice to look at) | 2.3[a] | 2.3[a] | 2.0[b] | 3.5[c] |
| | The species is indigenous | 2.5[a] | 2.6[a] | 2.3[b] | 3.4[c] |
| | I don't choose, the trees come naturally | 3.2[a] | 3.4[a,b] | 3.5[b] | 3.3[a,b] |
| | It should enable natural regeneration of the forest | 3.0[a] | 2.7[b] | 3.0[a] | 3.4[c] |
| | The species is recommended by someone I trust | 2.5[a] | 2.3[b] | 2.8[c] | 4.1[d] |
| | Availability at my nursery | 3.4[a] | 3.8[b] | 4.1[c] | 4.6[d] |
| 21 | ''How important is each of the following factors in your choice of felling and regeneration method? | Av.* rating | Av. rating | Av. rating | Av. rating |
| | Financial considerations | 2.6[a] | 1.9[b] | 3.5[c] | 4.2[d] |
| | Known technique | 2.7[a] | 2.1[b] | 3.2[c] | 4.3[d] |
| | Reliability with respect to tree survival and growth | 2.1[a] | 1.6[b] | 2.0[c] | 3.2[d] |

**Table 1** continued

| Question no. | Question | Cl | C2 | C3 | C4 |
|---|---|---|---|---|---|
| | Expert advice | 2.6[a] | 2.0[b] | 2.6[a] | 4.0[c] |
| | Subsidies | 2.9[a] | 2.5[b] | 3.3[c] | 4.2[d] |
| | Ecological concerns | 3.3 [a] | 2.9 [b] | 3.1 [c] | 4.1 [d] |
| | Groundwater protection concerns | 2.8[a] | 2.5[b] | 2.7[a,b] | 3.7[c] |
| Number of cluster members | | 383 | 380 | 244 | 77 |

Abbreviations: C1...C4: Cluster 1...Cluster 4

Different letters (a, b, c, d) are used for estimates that are significantly different at the 5% level

* 1 = very important ... 5 = absolutely not important

As it is highly likely that some pairs of the variables of Table 1 are associated, models were developed where the independence assumption was relaxed, i.e. selected variables were assumed to be associated. Models were developed for 0–8 associations and with up to 8 classes. These models were compared using Bayesian Information Criterion to select the model with the best possible description of the data and, for practical reasons, without too many classes. More details on latent class analysis can be found in Vermunt and Magidson (2003a, b).

The resulting clusters were described with regard to socio-demographic characteristics, perceived importance of various sources of information, and membership of associations. Estimated mean values for the four clusters were compared using t-tests, and relative frequencies compared using odds-ratio tests.

## Findings from The Statistical Analysis

The two best performing models were found to be a four-cluster solution with seven direct associations, and a five-cluster solution with eight direct associations. The focus of this paper is on the four-cluster solution. Associated variables were logically related and highly correlated. A few examples are: 'Christmas tree harvest' and 'Greenery harvest', 'Spraying' and 'Planting after (clear) felling', and 'I don't choose, the trees come naturally' and 'It should enable natural regeneration of the forest'. Clusters 1, 2, 3 and 4 include 35% (383 respondents), 35% (380 respondents), 23% (244 respondents), and 7% (77 respondents) of the sample responses used in the analysis (1084 respondents). A total of 469 respondents could not be assigned a cluster due to incomplete responses. The 469 respondents had highly heterogeneous response patterns and on average they answered only 55% of the questions regarding tree species choice and 33% of the questions regarding felling/regeneration, so choosing the approach of omitting incomplete observations was considered preferable to an approach where missing responses were imputed.

### Activities of Owners in the Past Five Years

When comparing the average responses from the four clusters, a common response pattern appears with respect to the activity index (Table 2), expressed as the number of different activities that were carried out within the past 5 years. In general, the larger the average forest area of a cluster the greater the number of activities, which

**Table 2** Percentages and mean values for variables describing the clusters

| Variable | Definition | Unit | C1 | C2 | C3 | C4 |
|---|---|---|---|---|---|---|
| Activity index | Index based on the reported activities* | – | $4.1^{a}$ | $9.7^{b}$ | $7.4^{c}$ | $3.0^{d}$ |
| Forest area | Mean forest area | ha | $22^{a}$ | $140^{b}$ | $41^{c}$ | $11^{d}$ |
| | Deciduous forest, mean share of forest area | % | $28^{a}$ | $41^{b}$ | $34^{c}$ | $35^{a,b,c}$ |
| Location | East of Storebaelt (East Denmark) | % | $19^{a}$ | $31^{b}$ | $15^{a}$ | $14^{a}$ |
| Sex | Male owners | % | $83^{a}$ | $88^{a}$ | $87^{a}$ | $82^{a}$ |
| Age | Mean age of owner | years | $51.0^{a}$ | $52.5^{a}$ | $52.1^{a}$ | $52.8^{a}$ |
| | Mean duration of ownership | years | $18.9^{a}$ | $19.5^{a}$ | $16.8^{b}$ | $19.1^{a,b}$ |
| Way of acquisition | Inherited | % | $11^{a}$ | $24^{b}$ | $7^{a}$ | $9^{a}$ |
| | Bought from spouse, relatives or friends | % | $37^{a,c}$ | $32^{a,b}$ | $29^{b}$ | $44^{c}$ |
| | Bought at the open market | % | $38^{a}$ | $37^{a}$ | $53^{b}$ | $42^{a,b}$ |
| | The owner planted the forest him-/herself | % | $11^{a}$ | $5^{b}$ | $8^{a,b}$ | $3^{b}$ |
| Own farmland | Owner also owns farmland | % | $81^{a}$ | $83^{a}$ | $70^{b}$ | $86^{a}$ |
| Agricultural affiliation | Owner is born on farm with forest | % | $53^{a}$ | $60^{a}$ | $43^{b}$ | $48^{a,b}$ |
| | Born on farm without forest | % | $23^{a}$ | $12^{b}$ | $20^{a}$ | $23^{a}$ |
| | Not born on farm but family/friends with agric. affil. | % | $9^{a}$ | $14^{b}$ | $14^{b}$ | $8^{a,b}$ |
| | Not born on farm but I have other agric. affil | % | $3^{a}$ | $4^{a}$ | $5^{a}$ | $0^{a}$ |
| | No agricultural affiliation. | % | $11^{a,b}$ | $9^{a}$ | $17^{b}$ | $19^{b}$ |
| Agr. education | Owner has an agri- or silvicultural education | % | $57^{a}$ | $61^{a}$ | $41^{b}$ | $49^{a,b}$ |
| Owner type | Full- or part-time forest owner (self-perception) | % | $36^{a}$ | $50^{b}$ | $49^{b}$ | $17^{c}$ |
| | Full- or part-time farmer (self-perception) | % | $58^{a}$ | $44^{b}$ | $47^{b}$ | $75^{c}$ |
| | Other | % | $5^{a}$ | $5^{a}$ | $3^{a}$ | $3^{a}$ |
| Vicinity | The forest is near the residence | % | $77^{a}$ | $79^{a}$ | $70^{b}$ | $82^{a}$ |
| Visit days | Mean annual no. of days in the forest | days | $102^{a}$ | $157^{b}$ | $135^{c}$ | $92^{a}$ |
| | Mean annual no. of hunting days | days | $7^{a}$ | $10^{a,b}$ | $10^{b}$ | $9^{a,b}$ |
| | Mean annual no. of recreation days | days | $48^{a}$ | $67^{b}$ | $71^{b}$ | $49^{a,b}$ |
| | Mean annual no. of work days | days | $32^{a}$ | $62^{b}$ | $37^{a}$ | $18^{c}$ |
| Map and Plan | Map of forest (%) | % | $13^{a}$ | $50^{b}$ | $25^{c}$ | $3^{d}$ |
| | Management plan (%) | % | $4^{a}$ | $26^{b}$ | $13^{c}$ | $3^{a}$ |

Abbreviations: C1...C4: Cluster 1...Cluster 4

Different letters (a, b, c, d) are used for estimates that are significantly different at the 5% level

* The activity index is defined as the number of reported activity types in Question 19 (Fuelwood cutting ... Management planning), cf. Table 1. Hence, the activity index is found in the range [0; 14]

were carried out. Thus owners in Cluster 2 (average area 140 ha) carried out the greatest number of activities followed by owners in Cluster 3 (average area 41 ha), Cluster 1 (average area 22 ha) and Cluster 4 (average area 11 ha).

The activity index was found to be linearly related to the logarithm of the forested area. Logistic models were therefore prepared using the procedure LOGISTIC in the statistical software package SAS to relate forest area and cluster to the probability of each particular activity occurring, i.e. $\text{logit}(P_{ij}) = C_{ij} + b_j \ln(A)$, where $A$ is forested area, $b_j$ is a coefficient, $C_{ij}$ is a cluster effect and $P_{ij}$ is the relative frequency of activity $j$ in cluster $i$. The resulting model was used for predicting the probability of each activity for forest properties with a given area. Figure 1 presents such area-corrected probabilities for properties with forested areas of 10 and 250 ha (these two areas being chosen as intermediate to the four clusters).

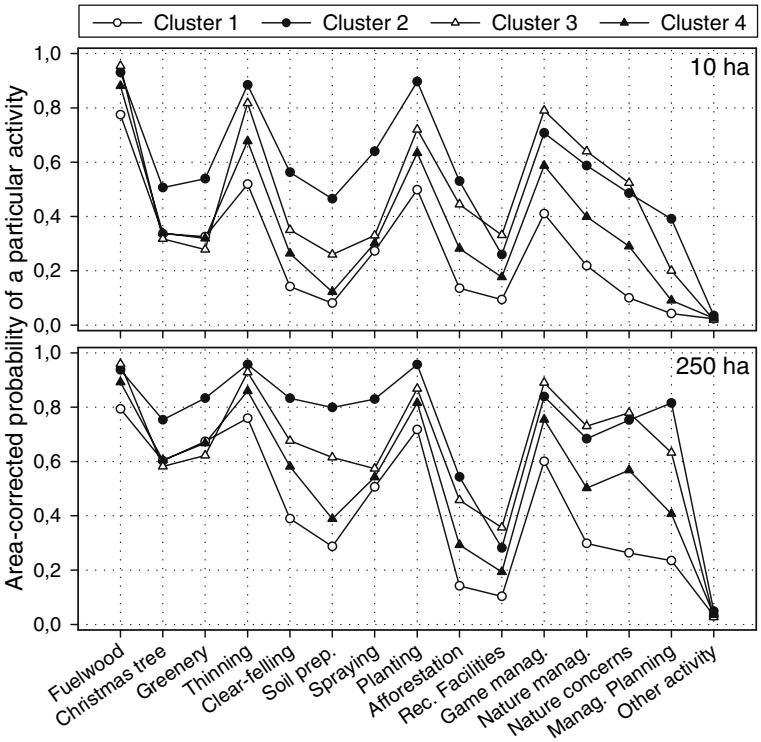


**Fig. 1** Area-corrected probabilities of an owner reporting that each of the activities mentioned in Question 19 (cf. Table 1) have been carried out during the latest 5 years. Top: properties with a forested area of 10 ha; bottom: properties with a forested area of 250 ha

As indicated in Table 1, Cluster 3 has the greatest percentage of owners who have carried out activities related to recreational facilities, nature management and game management. However, when correcting for differences with respect to area it emerges that this environmental profile of Cluster 3 is enhanced because the expected probability of activities in the category 'Nature concerns, other' is slightly greater than for any other cluster. Similarly, the crude percentages of owners reporting activities in the categories 'Christmas tree harvest' and 'Greenery harvest' (Table 1) indicate that in these respects the activity of owners in Cluster 3 is similar to that of Cluster 1 and greater than for Cluster 4, but it turns out that the area-corrected, expected probability of such activities is slightly lower for Cluster 3. According to the percentages in Table 1 and the activity index in Table 2, Cluster 2 has the greatest activity level in all other respects, apart from fuelwood cutting. This ranking is not changed by correcting for forest area. However, the low percentages observed for Cluster 4 with respect to 'Fuelwood cutting', 'Thinning', 'Clear-felling', 'Soil preparation', 'Spraying', 'Planting', 'Game management', 'Nature management' and 'Management planning' turn out to be a consequence of the low average forest area of this cluster and the area-corrected activity of Cluster 1 is actually lower in these respects than that of Cluster 4.

## Perceived Importance of Various Factors

The reported attitudes towards various factors influencing the choice of tree species are broadly in agreement with the activities carried out within the past 5 years. Moreover, the general rating of the proposed factors decreases with decreasing average forest area.

All clusters tend to agree that survival and growth of trees is the most important factor for the choice of regeneration method. Moreover, except for Cluster 4, owners in all clusters agree that some of the most important factors for the tree species choice are that the species should be robust, site adapted, and stable in the cultivation phase. Owners in Cluster 4 prefer natural regeneration.

Like for the activity levels, considerable differences can be observed between the attitudes characterising the four clusters. Owners in Cluster 4, which has a relatively low activity level (although perhaps not quite as low as immediately appears in Table 1), attach less importance to most of the factors than any of the other clusters, the only exception being the factor labelled 'I don't choose, the trees come naturally'. Similarly, it is notable that owners in Cluster 2 attach more importance to most factors than owners in any other cluster, the exceptions being 'The species is aesthetic', 'The species is indigenous', 'I don't choose, the trees come naturally' and 'Availability at my nursery'. Cluster 3 owners attach significantly more importance to the factors 'The species is aesthetic (nice to look at)' and 'The species is indigenous' than owners in any other cluster. The main difference between Clusters 1 and 3 is that owners in Cluster 1 attach more importance to 'Plant price', 'Subsidies', 'The species is economically valuable', 'The species is fast growing', and 'Availability at my nursery' than do owners in Cluster 3. On the other hand, owners in Cluster 3 attach more importance to 'It is a deciduous species' than do owners in Cluster 1.

The reported attitudes towards factors influencing the choice of felling and regeneration methods follow the general pattern described above. Again the general importance of the nominated factors decreases with increasing average forest area. Cluster 4 owners generally attach less importance to the factors than owners in any other cluster, Cluster 2 owners find them more important than owners in the other clusters, and the attitudes of owners in Clusters 1 and 3 are intermediate. The main differences between Clusters 1 and 3 are observed with respect to 'Financial considerations', 'Known technique', 'Subsidies' and 'Ecological concerns', where not surprisingly owners in Cluster 1 attach more importance to the first three than owners in Cluster 3, whereas owners in Cluster 3 find 'Ecological concerns' more important.

Based on the above observations it appears that Cluster 3 has a more environmentally oriented profile than any of the other clusters. Cluster 2 on the other hand appears to include the most professional forest owners, owning large forest properties, having a high activity level, and attaching considerable importance to most nominated factors, particularly those that are related to silvicultural issues. The members of Cluster 4, on the other hand, are owners of small forest properties and do not attach much importance to any of the proposed factors. Clusters 1 and 3 are located between these two extremes but whereas owners in Cluster 3 emphasise aesthetics and ecological concerns and exhibit a relatively high level of activity within these areas, owners in Cluster 1 mainly attach importance to economic and practical issues. The characteristics of the clusters are further described by the variables outlined in Table 2, as discussed below.

### Cluster 1, the Production-Oriented Owner

Cluster 1 is labelled 'the production-oriented owner'. This cluster has the highest share of owners with strong agricultural affiliation (born on farm with/without forest), a high share of owners who also own farmland (81%) and a relatively stronger focus on production relative to environmental issues than other clusters, except for Cluster 2. In addition, Cluster 1 has the second-highest share of owners with an agricultural education. Together with Cluster 4 it has a higher share of female owners than the other two clusters, and it includes the youngest forest owners. The forest has been acquired in various ways, and it is the cluster where the greatest percentage of owners has planted the forest themselves (11%). Cluster 1 also has the lowest share of deciduous forest.

Cluster 1 has the second-smallest average forest area (22 ha) and, as expected, the second-lowest activity index (4.1). The only activities for which the area-corrected activity level of Cluster 1 is similar to that of other clusters are 'Christmas tree and greenery harvest' and 'Spraying'. Owners in Cluster 1 attach the second highest importance to some of the factors influencing regeneration and tree species choice, notably financial and wood production aspects. Along with the stronger production focus, owners in Cluster 1 are on average less active as regards environmental activities (recreational facilities, game management, nature management) than owners in other clusters. Owners in Cluster 1 spend the lowest number of hunting and recreation days annually in the forest, even less than owners in Cluster 4 although not significantly so.

### Cluster 2, the Classic Forest Owner

Cluster 2 represents the owners of large forests who generally have a high activity level compared to owners in other clusters, even when corrected for the effect of forest area. For these owners financial and wood production issues are the most important to consider when choosing tree species and regeneration method. The label 'classic forest owner' has been chosen for this cluster.

Cluster 2 has the largest average forest area (140 ha). This cluster also has the highest activity level, only surpassed by Cluster 3 with respect to activities related to recreational facilities, game and nature management and fuel-wood cutting.

With a few exceptions, owners in Cluster 2 attach more importance than owners in other clusters to all the suggested factors related to regeneration and tree species choice, including financial, silvicultural and environmental factors. But contrasted with the profile of Cluster 3, owners in Cluster 2 have a relatively stronger focus on the financial and silvicultural aspects (survival of trees, robust species, site adapted) than environmental aspects (indigenous, aesthetic).

Cluster 2 has the highest shares of deciduous forest and properties located on the islands of Eastern Denmark, which are characterised by fertile soils. Cluster 2 also has the highest share of owners born on a farm with forest, having inherited the forest, having an agricultural or silvicultural education, and spending most days in total in the forest. Finally, it has the highest share of owners perceiving themselves as full- or part-time forest owners and, as expected, it also has the highest share of owners that possess a forest map or a management plan.

### Cluster 3, the Environmental/Recreational Owner

Cluster 3 has the second-largest average forest area (41 ha) and, as expected, the second-highest activity index (7.4). In absolute terms, Cluster 3 has the most owners who have carried out activities regarding recreational facilities, game management and fuelwood cutting, and the cluster is also relatively more active in nature management, compared to Clusters 1 and 2. The area-corrected activity level is greater than for any other cluster with respect to recreational facilities, game management, nature management, other nature concerns and fuelwood cutting.

Owners in Cluster 3 are generally less motivated by the financial and wood production factors influencing choice of tree species than owners in Clusters 1 and 2. Furthermore, it is the cluster most strongly motivated by environmental factors, i.e. that tree species should be indigenous, deciduous (more than Clusters 1 and 4), and aesthetically appealing.

Cluster 3 has the largest share of owners who purchased the forest on the open market, indicating that they became forest owners through an active choice. Together with Cluster 4, Cluster 3 has the lowest share of owners from Eastern Denmark. And Cluster 3 is the cluster where fewest owners grew up on a farm, fewest owners have an agricultural education, the duration of ownership is shortest, and the proportion of owners living next to their forest is lowest. Still, the cluster has the highest average annual number of hunting and recreation days. Based on this profile, Cluster 3 is labled 'the environmental/recreational owner'.

### Cluster 4, the Indifferent Forest Owner

Cluster 4 includes owners of the smallest forest properties (average 11 ha), and it has the lowest average activity index (3.0). The activity of both Clusters 1 and 4 is low when it comes to nature and game management, and recreational facilities. Owners in Cluster 4 are least motivated by any of the motivation factors related to regeneration and tree species choice. They are relatively more motivated by tree survival and environmental factors (aesthetics, groundwater protection) than by financial and wood production factors.

Cluster 4 has the lowest share of owners from Eastern Denmark, the greatest share of female owners and, on average, the oldest owners, although not significantly so. It is the cluster with the highest share of owners also owning agricultural land but, compared to Clusters 1 and 2, relatively fewer owners in Cluster 4 have an agricultural education, and slightly more have no agricultural affiliation. Cluster 4 also has the highest share of owners living next to the forest, the lowest total number of days spent in the forest annually and slightly more hunting and recreation days than Cluster 1, although the average forest area of Cluster 4 is half that of Cluster 1.

## Discussion And Perspectives

An important aim of *The Danish Forest Act 2004* is to improve the environmental aspects of forest management. How can this best be pursued, knowing the four clusters?

If the composition of the sample with respect to forested area is taken into account and incomplete observations are distributed proportionally to the four clusters—i.e. assuming that the proportion of incomplete observations is the same in all clusters—then the estimated shares of the private forest area owned by Clusters 1–4 are 27, 49, 19 and 5%, respectively.

In a policy perspective, Clusters 1 and 2 are most interesting as they possess the largest forest area, whereas owners in Cluster 3 may be most easily motivated for environmentally oriented management. For effective policy intervention, the clusters should be addressed by different means, taking their motivation profile into account as well as their preferred sources of information, see Table 3.

## Motivation Profile

It is likely that owners in Clusters 1 and 2 are more easily motivated to choose a specific management approach if they are convinced that it is financially viable and compatible with silvicultural demands regarding tree survival, stability and high quality wood production. By contrast, owners in Clusters 3 and 4 are likely to be motivated by knowing that a management approach will increase the environmental value of the forest, although Cluster 4 owners and appear less easy to motivate in general. Cluster 4 includes the smallest proportion least forestry-motivated owners who appear to be mainly interested in passive nature management solutions, e.g. setting aside areas as untouched.

The production motivation of Cluster 2 is easily explained because this cluster includes owners of the largest properties. Obviously they need to consider the

**Table 3** Perceived importance of various sources of information and memberships of associations

| | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 |
|---|---|---|---|---|
| Information source, perceived importance | Av. rating* | Av. rating | Av. rating | Av. Rating |
| Professional literature | 3.2[a] | 2.3[b] | 3.1[a] | 4.1[c] |
| Forestry booklets from the Danish Forest and Nature Agency | 3.3[a] | 2.6[b] | 3.4[a] | 4.3[c] |
| Scientific Forestry leaflets | 3.4[a] | 2.8[b] | 3.5[a] | 4.5[c] |
| Courses, seminars, excursions | 3.5[a] | 3.0[b] | 3.8[c] | 4.5[d] |
| Agricultural association | 3.5[a] | 3.5[a] | 4.0[b] | 4.4[c] |
| Own forestry advisor | 3.5[a] | 2.7[b] | 3.6[a] | 4.4[c] |
| Danish Forestry Extension | 3.0[a] | 2.9[a] | 3.4[b] | 4.1[c] |
| DDH HedeDanmark a/s | 3.3[a] | 3.3[a] | 3.6[b] | 4.4[c] |
| Family, friends etc. | 3.1[a] | 3.1[a] | 3.2[a] | 3.9[b] |
| State forest district | 3.6[a] | 3.6[a] | 3.8[a] | 4.4[b] |
| Research institutions | 3.7[a] | 3.4[b] | 4.0[c] | 4.6[d] |
| Forestry College a.o. silvicultural schools | 3.7[a] | 3.6[b] | 4.1[c] | 4.6[d] |
| Television, radio, newspapers | 3.4[a] | 3.3[a] | 3.6[b] | 4.3[c] |
| Internet | 3.6[a] | 3.4[b] | 3.8[a] | 4.4[c] |
| Membership of the following associations | % | % | % | % |
| The Danish Forest Association | 6.8[a] | 38.7[b] | 19.3[c] | 6.5[a] |
| Danish Forestry Extension | 36.8[a] | 45.8[b] | 33.6[a] | 16.9[c] |
| DDH HedeDanmark a/s | 14.9[a] | 28.9[b] | 20.9[a] | 5.2[c] |
| Christmas Tree Growers association | 7.8[a] | 32.4[b] | 8.2[a] | 2.6[a] |
| Agricultural association | 59.3[a] | 63.7[a] | 48.0[b] | 58.4[a,b] |

Different letters (a, b, c, d) are used for estimates that are significantly different at the 5% level

* 1 = very important ...5 = absolutely not important

financial consequences of their management choices. This would lead us to assume that owners in Cluster 3 should be more production oriented than owners in Cluster 1, having a smaller average forest area, whereas the opposite is apparently true. A likely explanation is that for owners in Cluster 1 the forest is usually part of a farm production system, managed according to their agricultural education, whereas more Cluster 3 owners own only the forest, apparently having the character of a hobby or recreational object. So Cluster 3 owners are likely to exhibit environmentally friendly behaviour simply by being informed about this, whereas owners in Cluster 1 need to see the financial and production logic of such a behaviour, e.g. that it improves the amenity and, thereby, the total value of the farm property. This is in line with Emtage et al. (2006) who suggested that landowner behaviour is affected by the 'land management ethic' landowners learn from their parents as well as those in their social group.

### Means of Communication

Forest owners can be addressed through organisations and networks, through professional news media or literature, or through the news media in general. The forest owner's valuation of the different sources of information and organisational affiliation indicates that the most effective means of communicating with owners goes through personal networks and their organisational affiliations (summarised in Table 3).

Clusters 1, 2 and 4 are characterised by more than 50% of the owners being members of an agricultural association. From that perspective, agricultural associations could be entry points of communication with owners. This is a particularly relevant option for Cluster 4 because this cluster is not well represented in any of the other organisations. However, as indicated in Table 3, the owners themselves do not perceive agricultural associations as important sources of forestry information. Instead, owners in Clusters 1 and 2 may be reached more effectively through Danish Forest Extension, or DDH HedeDanmark a/s, as particularly Danish Forest Extension is valued as a relatively more important source of forest information. It is notable, however, that even for this organisation the *average* rating is from 2.9 (cluster 2) to 4.1 (cluster 4), i.e. from 'neutral' to 'unimportant'.

The personal network of family and friends is a relatively important source of information for the owners from Clusters 1, 3 and 4, whereas Clusters 2 owners rely more on their forest advisor. This suggests that using the 'good example' could be an effective means of affecting management behaviour, following innovation diffusion theory (as described by Rogers 1995), i.e. to have some respected, well-known forest owners, who are opinion leaders, to take the lead in a management change and then leave it to the network to 'spread the message'.

Professional literature appeals to all clusters, relative to other sources of information, with Cluster 2 owners valuing it as most important. Unfortunately, the responses do not identify exactly which topics the owners in the different clusters want covered. The less valued sources of information among all owner groups are: courses, excursions and television/radio/internet and, even lower ranked, the state forest districts, the Forestry College and research institutions.

These findings imply that if the Government aims to have near-to-nature forest management implemented in private forestry in Denmark, and if research is to have an impact on forest owners, then it is essential to go through the networks of private

owners, in particular the forest professionals, including Danish Forestry Extension. The forest professionals are the ambassadors and 'interpreters' of governmental policy and new knowledge on forest management. It therefore makes good sense that the Government has for years provided a grant to consultant companies offering advisory services to private forest owners. A recent survey revealed that owners and professionals consider the consultancy services provided to be in overall agreement with the aims of the *Forest Act*, but that the professionals need continued education when it comes to biodiversity and near-to-nature management (Lund and Vedel 2005). So it is recommended that the Government stimulates continued education opportunities for these foresters, e.g. in combination with continued education programs that already take place for public foresters in the National Forest and Nature Agency on near-to-nature-management through forest development types (Larsen and Nielsen 2007) and, previously, the program 'Richer Forest'.

For future research it would be relevant to explore forest owners' use of information in more detail. Do owners actively seek forest related information at all, or is such information simply passively accepted whenever it comes by? And what does it take for owners to consider information as relevant and accountable? How frequently do owners use the various sources of information, and is a source of information considered (un-)important based on experience or based on pure assumption? For instance, Table 3 indicates that the internet is considered unimportant. This may be because the forest owners do not use the internet at all, but it is more likely to be due to owners not seeking forestry related information on the internet. This may be because they do not expect the internet to be a source of accountable expertise, because they do not know where to look, or because they simply do not actively seek forest-related information. Active information searching is a primary requisite for being able to use the internet, as opposed to using other forms of mass media, e.g. reading the daily newspaper. So although results showed that the internet was considered less important, it has a development potential, particularly because it allows owners to combine personal networks and professional literature, e.g. through chat rooms and other interactive fora. One example of this is the European Pro Silva network, a network for foresters designed to enhance 'forest management based on natural processes' (at web address www.prosilva.dk).

**Acknowledgements** The authors would like to thank the three anonymous reviewers and the editor, Associate Professor Steve Harrison, for their insightful and constructive review of the paper. The authors would also like to acknowledge the financial support of the Danish Agricultural and Veterinary Research Council enabling this study.

## References

Becker G, Borchers J, Mutz R (2000) Die Motive der Privatwaldbesitzer in NRW [Motivations of private forest owners in NRW]. Allgemeine Forst- und Jagd-Zeitung 55(22):1180–1183 (In German)

Bieling C (2004) Non-industrial private forest owners: Possibilities for increasing adoption of close-to-nature forest management. Eur J Forest Res 123(4):293–303

Boon TE (2003) Hvad mener de danske skovejere? Spørgeundersøgelse blandt private skovejere i Danmark [What do the Danish Forest Owners Think? A Survey among Private Forest Owners in Denmark]. Skovbrugsserien nr. 33, Skov og Landskab, Hørsholm. 73 pp (In Danish)

Boon TE, Meilby H, Thorsen BJ (2004) An Empirically Based Typology of Private Forest Owners in Denmark—Improving the Communication between Authorities and Owners. Scand J Forest Res 19(suppl.4):45–55

Emtage N, Herbohn J, Harrison S (2006) Landholder profiling for natural resource management policy and program support: potential and constrains. Aust J Environ Manage 13(2):79–94

Hogl K, Pregernig M, Weiss G (2005) What is New about New Forest Owners? A Typology of Private Forest Ownership in Austria. Small-scale Forest Econ Manage Policy 4(3):325–343

Härdter U (2002) Urbanised owners of private forest property. Paper presented at IUFRO - International Symposium on Contributions of Family Farm Enterprises to Sustainable Rural Development. July 29–August 1, 2002 in Gengenbach/Schwarzwald

Ingemarson F, Lindhagen A, Eriksson L (2006) A typology of small-scale private forest owners in Sweden. Scand J Forest Res 21:249–259

Karppinen H (1998a) Objectives of Non-industrial Private Forest Owners: Differences and Future Trends in Southern and Northern Finland. J Forest Econ 4(2):147–173

Karppinen H (1998b) Values and Objectives of Non-industrial Private Forest Owners in Finland. Silva Fennica 32(1):43–59

Kline JD, Alig RJ, Johnson RL (2000) Fostering the production of nontimber services among forest owners with heterogenous objectives. Forest Sci 46(2):302–311

Kuuluvainen J, Karppinen H, Ovaskainen V (1996) Landowner objectives and non-industrial private timber supply. Forest Sci 42(39):300–309

Larsen PH, Johannsen VK (2002) Skove og Plantager 2000 [Forests and Plantations 2000]. Danmarks Statistik, Skov og Landskab and Skov- og Naturstyrelsen, København (In Danish)

Larsen JB, Nielsen AB (2007) Nature-based forest management – where are we going? Elaborating forest development types in and with practice. Forest Ecol Manage 238:107–117

Lund DH, Vedel S (2005) Tilskud til rådgivning i skovbruget [Subsidies to advisory services in forestry]. Thesis. Skov og Landskab, Royal Veterinary and Agricultural University, Copenhagen (In Danish)

Madsen LM (2003) New woodlands in Denmark: the role of private landowners. Urban Forestry Urban Green 1(3):185–195

Meilby H, Boon TE (2004) Comparison of forest owner typologies based on latent class analysis and cluster analysis. In: Pajuoja H, Karppinen H (eds) Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics, Vantaa, Finland, 12–15. May 2004. Scandinavian Forest Economics 40:179–188

Rogers E (1995) Diffusion of innovations. The Free Press, New York

Skov- og Naturstyrelsen (2004) The Forest Act. Unofficial translation of the Danish Forest Act. URL: http://www.skovognatur.dk/NR/rdonlyres/EAA70428-BD36–4C17-B705–8B97029FC8ED/8281/Forestact.pdf (Accessed 19 January 2007)

Vanclay J (2005) Using a typology of tree-growers to guide forestry extension. Annal Trop Res 27(1):97–103

Vermunt JK, Magidson J (2003a) Latent Gold: User's Guide. Statistical Innovations, Belmont, MA

Vermunt JK, Magidson J (2003b) Technical Appendix for Latent Gold 3.0. Statistical Innovations, Belmont, MA. 53 pp

Volz KR, Bieling A (1998) Zur Soziologie des Kleinprivatwaldes [The sociology of small privately owned forests]. Forst und Holz 3/1998:67–71. (In German)